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**ORCHARD STUDIES—XIII. Some observations on Crown
Gall of Apple Trees.**

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ORCHARD STUDIES—XIII.

SOME OBSERVATIONS ON CROWN GALL OF APPLE TREES.

Previous to 1896, we had practically no acquaintance with Crown Gall of the apple. While considerable work had been done on root galls of some other plants, little or no attention had been given to this trouble. In Virginia it was unknown outside of those whose attention had been especially called to it, up to that date. However, when I first began to give attention to the nurseries of the State, in the efforts to stay the spread of the San Jose scale, the crown gall was occasionally observed in small amount here and there. No one felt alarmed and while we had no data on which to base conclusions as to the probable outcome of this trouble, we kept it under observation from the first.

During the four years subsequent to 1896, the occurrence of this disease in the nurseries increased to an alarming extent, yet still few realized its serious character because of lack of observation and experience with it on orchard trees. Many nurserymen were quite unwilling to accept the conclusion that this was a new trouble which promised much harm to the orchardist. It was frequently stated by them that this identical trouble had occurred for many years and that some varieties, as for example, Lady Apple, were never free from it. But our observations showed that the very hardiest standard varieties were equally susceptible to the attack of the present trouble. When such varieties as Winesap, York Imperial, Ben Davis, Black Twig, and others came to show a large per cent. of the nursery trees carrying this abnormal growth, the nurserymen yielded with better grace to the decision of the Board of Crop Pest Commissioners that apple trees bearing these gall or cancerous like growths, should be excluded from sale in this State.

It is not our purpose in this paper to trace the origin or history of this trouble, but to set forth some simple observations, which, though incomplete, are fairly convincing as to the source of the trouble, as to

how it gains access to our nurseries, and which also seem to point clearly to the conclusion that every planter must be prepared to detect this trouble and exclude it from his orchard plantings.

For the purpose of determining with some exactness the facts in regard to the sources of crown gall on nursery trees, a quite comprehensive experiment was planned and executed during the winter and Spring of 1902. The question which appeared most important to settle was whether the crown gall was brought into our nurseries on the seedling stocks purchased from the growers of such stocks; whether the disease existed normally in the soil; or whether, as many nurserymen have claimed, this abnormal growth at the crown is a large callous at the point of union of cion and stock and not a specific disease.

As material to be used in this experiment, seedling apple trees were collected from several different nurserymen, in Virginia, and as far as possible, we traced the source of this stock to the original points where the seedlings were grown. Most of this material came originally from the large Western growers of seedling apple stocks.

For a year or so previous to the undertaking of this experiment, we had occasionally received seedling apple stocks from nurserymen which showed an abnormal growth of fibrous roots upon the tap root. This abnormal growth consisted of more or less marked clusters of delicate, fibrous roots, occurring most frequently at and below the crown, for the space of an inch to an inch and a half on the main root. Roots showing this marked fibrous growth have a wooly appearance. The nurserymen had on different occasions consulted us as to whether these seedling roots were diseased or not, and we had from the start advised them not to use them, believing that they were already infested with the organism which produces the crown gall.

Several batches of seedlings containing both healthy and diseased roots were procured from different sources, and the roots sorted into healthy and apparently diseased stock. The appearance of the roots used in the experiment, is shown in Fig. 27, where A represents an apparently sound stock; B, one only slightly diseased, and C, a seedling root showing very marked growth of the fibrous rootlets mentioned above. At D, same figure, is shown a nearly natural size illustration of a diseased seedling root.

The plan pursued in this experiment was as follows: to use the apparently diseased seedlings as root stocks in comparison with the apparently healthy seedlings selected from the same sources. In each experiment, barring exception noted below, the apparently diseased roots were made into three cuts, viz: top, middle and tip pieces, and each portion kept separate. Onto these three sections of the root, healthy grafts were set by the ordinary whip graft method. The pieces of root used varied from three to four inches, and

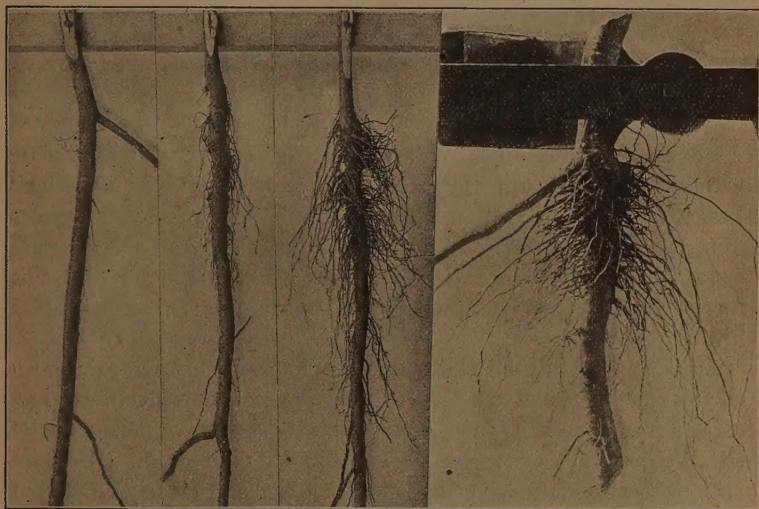


Fig. 27—Healthy and diseased roots of apple seedlings.

the cions used were ordinarily four to five inches long. For cions we used wood cut from the Experiment Station nursery and orchard. The varieties most used for this work were Winesap, York Imperial, Ben Davis, Gano and Black Twig.

As a check upon the results, each lot of grafts placed upon the apparently diseased pieces of roots were exactly duplicated upon apparently healthy roots, and the grafts so made were planted adjacent in nursery rows, so that they might be grown under identical conditions, and in close juxtaposition, thus making it possible to secure an accurate and fair comparison of results.

A further experiment also was undertaken of inoculating into grafts made on healthy stocks, portions of the diseased tissue from galls on young nursery trees which showed decided cases of the crown gall, and like portions were also inoculated into seedling stocks which were not grafted. Sowings of minced galls were also made along with healthy stock when planted.

Further experiments in the way of cutting off and washing gall diseased trees were undertaken, the details of which will appear under the several headings below.

NOTES ON THE EXPERIMENTS.

Plot 1.

Diseased seedling apple roots were used, the top cut was grafted with cions of York Imperial; second cut grafted with cions of Black Twig; the third cut grafted with Stayman Winesap. Twelve grafts were made in each section and planted May 23, 1902. Notes were kept upon the growth of these plants during the summer of 1902, but furnished no data of sufficient importance to warrant incorporation in this report.

April 10, 1903, all the plants on this plot were dug and examined. Of the grafts made on the top cut from the root, only five lived, and these are rather weak; three of these plants showed decided cases of crown gall, the other two are also apparently diseased, but the cases are not so pronounced. Of the plants propagated on the middle cut of the roots, only six grew, and these are also weak plants. All show decided cases of crown gall, more marked than with those plants propagated on the top cuts of the root. Of the grafts made on the third cut or tip of the root, only one survived, and this plant is weak; it shows a decided case of crown gall. It seems evident that the roots used in this experiment were already injured to such an extent that they were not able to start the grafts and produce trees. Fig. 28 shows a photograph of typical trees taken from this experiment. While the cancerous growth, so typical of the mature gall on two and three year nursery stock, does not show prominently in this figure, it is present, and the abnormal development of fibrous roots is very marked.



Fig. 28—One year grafts on diseased apple roots.

Plot 2.

This plot was planted with cions propagated on healthy roots. The top cuts of each were grafted with Black Twig, the second cuts with York Imperial and the third cuts with Gano. They grew very well during the Summer of 1902.

April 10, 1903. All of these plants were dug and examined, with the following results: that from the top cuts of the root, 11 strong, healthy plants were developed; from the second cut, 8 strong, healthy plants were developed; and from the third cut of roots, 5 plants developed, 4 strong and healthy, 1 rather weak. Not a case of crown gall occurred upon any plant in this plot. For comparison, a photo-engraving shown in Fig. 29 gives selected plants, showing the range of stock from best to poorest, as to vigor and appearance, grown on this plot. The plant at the extreme right is the weakest of any. It was grown from the tip cut of a seedling root.

Plot 3.

In this plot diseased stocks were used, selected and cut as indicated under Plot 1. The cions used were made ten inches long, so as to set the roots deep in the soil. Our purpose was to observe whether the cions would produce sufficient roots above the union with the stock to permit of cutting it away the following Spring, and thus enable us to observe whether we could produce in this manner a healthy tree from a cion on its own roots, but originally propagated on a seedling root which showed the early stages of crown gall. In this case the top cuts were grafted with Black Twig, second cuts with Gano and the third cuts with Stayman Winesap. 12 plants were used of the first two and 11 of the third. The seedling roots were badly diseased when grafted.

April 10, 1903. All these plants were dug and examined. Of the top cut, 8 plants developed and made a very good growth indeed, but every plant showed a bad case of crown gall. Only fibrous roots had developed from the portion of the seedling root used and the cions had scarcely developed any roots at all above the union with the stock. Of the second cut 9 plants developed; 3 made a good growth,

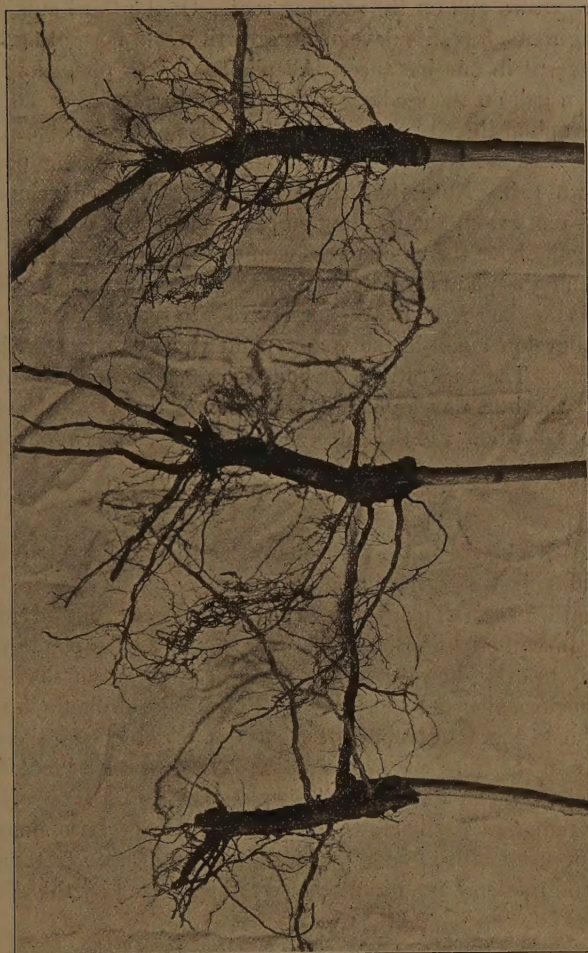


Fig. 29—One year grafts on healthy apple roots.

2 of which rooted well from the cion above the stock; 6 made a weak growth, 2 of them, however, rooted from the cion. All show distinct cases of crown gall on the seedling root. Of the third cuts from the seedling roots, 5 plants developed; growth weak, no rooting from the cion, except in one instance. All plants show a plain development of crown gall on the seedling root. The illustration, Fig. 30, shows a photograph of three plants selected from this plot. Each of the seedling roots show the growth of fibrous roots marking the occurrence of crown gall. Note that there is practically no development of normal roots from the seedling stocks. There was no appearance of crown gall above the union of the cion with the stock.

Part of the plants from this plot were selected, the seedling root cut off and then reset in the nursery row to see whether the disease would develop again in the young plant which is now wholly on its own roots. The illustration shown at Fig. 30, gives those plants which showed the best development of roots from the cion. Most of the plants, as mentioned in the notes, showed no development of roots from the cion.

Plot 4.

Plot 4 is a check on the previous. Healthy stocks were used, with long cions, just as given in detail above.

April 10, 1903. All plants grown on this plot were dug and examined. Not a trace of crown gall was discovered, and all the plants were apparently healthy, however, those from the third cut of the root were very much smaller than the others. The range of plants in this plot is shown in Fig. 31, the one on the extreme right being the weakest plant from the third cut of the roots. The contrast of root development on the seedling stock of these plants with that shown in Fig. 30 is very remarkable, the crown gall appearing to produce almost complete suppression of the normal root system, so that no strong lateral or central roots are produced on a seedling affected by this disease.

Plot 5.

This plot is a duplicate of Plot 1, except that the diseased stocks were procured from another source. The results in every way conform to the statements made concerning Plot 1, except that one plant



Fig. 30.—One year grafts, long cions used on diseased apple roots.

among those grafted on the second cut of the seedling root, shows only a slight development of the disease. So slight, in fact, that one would not be able to pronounce it a case of crown gall without further observation by growing it a second year. All the other plants showed plainly marked cases of the disease.

Plot 6.

Plot 6 was propagated upon some quite small roots which had been rejected from the stock purchased for grafting in the Experiment Station nursery. This stock was so weak and poor that only two pieces of the root could be used, namely, the top and second cut. It showed only the slightest trace of disease and might have passed muster as healthy stock, if one did not give it a rigid examination. It was propagated exactly as Plot 1, using ordinary length of cion, eight plants from each portion of the roots. From the top cut 8 plants developed. Growth fair, all diseased with crown gall, 2 are not decided cases. From the second cut, only 3 plants developed, one a very decided case of crown gall, one a slight case and one plant apparently healthy. These plants were replanted for further observation.

Plot 7.

In this experiment, strong, healthy, seedling stocks were used and the grafts set as usual in nursery work. After setting and wrapping the cion, a thin slice of a gall taken from a young apple tree obtained from one of the nurseries, was inserted at the point of contact of the cion with the stock. 12 plants were used.

April 10, 1903. 8 plants alive and in fair condition, though the growth has not been strong. 3 of these plants show incipient cases of crown gall. The others do not show a sufficient development of the disease to warrant one in saying they are diseased. None of the cases are so plainly marked as those upon plants where the cion has been propagated upon a root already diseased.

The root development of the plants on this plot, which are thought to be diseased, is strikingly in contrast with that of healthy plants, such as shown in Figs. 29 and 31. In the illustration, Fig. 32, is shown these characteristics. The root growth is neither altogether



FIG. 81.—Long clons grafted on healthy roots.

fibrous, like that from known diseased seedling roots, nor is it of the normal type where healthy roots were used. A close examination of the illustration will show the beginning of the gall at the point of the union with the stock. The striking difference of root development, presumably brought about by the insertion of a portion of the gall from a diseased tree, clearly separates these plants from normal types. The illustration does not give an exaggerated appearance of the plants.

Plot 8.

This plot is a check on No. 7. The grafts were not inoculated with gall tissue. Other than this the work was a duplicate of the previous number.

April 10, 1903. All the plants dug and examined, without finding a trace of disease upon them. The roots were normal, and in no case showed any development comparable to the root growths illustrated in Fig. 32. A photo of these plants is so like Fig. 29 that it is not reproduced.

Plot 9.

In this plot ordinary apple seedlings one year old were used. Apparently healthy seedlings were selected, and just below the crown of each, there was inserted under the bark, a thin slice of the gall tissue from an apple tree obtained from the nursery; 12 of these were planted. For some reason, only 6 grew and of these 4 show more or less decided cases of crown gall at the point where the insertion was made; 2 of them are apparently healthy, and show no abnormal development. The illustration, Fig. 33, shows the contrast between an apparently healthy plant, and one showing disease at the point of inoculation. The one on the right has a well developed gall on the root and begins to show the characteristic fibrous bundles of roots attached thereto, while the other plant has normal roots.

Plot 10.

In this apparently healthy seedlings were planted to compare with the above. No trace of crown gall could be found upon them when dug and examined, April 10, 1903.



FIG. 32.—One year grafts on healthy apple roots, inoculated with crown gall.

Plot 11.

Twelve apple trees were taken from the Station nursery, some 1 and some 2 years grafted. Just below the crown of each, an inoculation was made by using a small portion of crown gall tissue, as indicated above for Plot 9. These plants were all in fine condition and showed not the slightest trace of any abnormal growth when inoculated. They all grew.

April 10, 1903. Of the 12 plants, 9 showed decided cases of crown gall, 1 is suspicious and 2 are apparently healthy,

Plot 12.

A duplicate of the above, except that the plants were not inoculated. When examined April 10, 1903, these plants were all apparently healthy, except one that had a suspicious growth, but not sufficiently well developed to be positively determined as a case of crown gall.

Plot 13.

In this plot, healthy roots were grafted with Black Twig cions and planted in the nursery row. After planting these sets, some fresh galls from apple trees were finely minced with a sharp knife and then used for inoculating the soil about the plants. The earth was removed along the row and the minced galls scattered in contact with the sets, after which the earth was replaced.

April 10, 1903. 11 plants grew in this plot. All apparently strong, and they made good roots, some having rooted well from the stock and also from the cion. 2 of the plants show what we judge to be incipient cases of crown gall at the point of union of the stock with the cion. The other 9 appear to be entirely healthy. Further observation is necessary to determine whether bringing the portions of gall in contact with the newly grafted stock in this manner, is sufficient to inoculate apple plants. The illustration, Fig. 34, shows on the right the two plants with apparently incipient cases of crown gall at the union of stock and cion. No fibrous roots have yet developed. It also shows how well these plants rooted from the cion. Long cions were used in this plot.

Plot 14.

This was a check on the above, and all the plants were healthy when examined April 10, 1903.



Fig. 33—Seedling apple roots grown one year. Disease shows on right-hand specimen.

Plot 15.

One and 2 year apple plants selected from our nursery. 12 plants were used, all of which were apparently in healthy condition. After planting, minced galls were sown about the roots of these plants, as detailed in the experiment above.

April 10, 1903. All plants were dug and examined. The 12 plants are in good condition, but 2 show decidedly suspicious growths, and we think that they have contracted crown gall. The other 9 are apparently healthy. Planted for further observation.

Plot 16.

Check on the above. All of the plants were healthy when examined April 10, 1903.

Plot 17.

Eighteen seedling apple stocks which came to us from a nurseryman for examination, and which we pronounced to have the crown gall, were planted in this plot. The plants were all weak when they reached us, because they had been badly handled and all died but four. April 10, 1903, these plants were dug, they all showed decided cases of crown gall.

Plot 18.

Five feet of row sown with native apple seed and 5 feet of row sown with French apple seed. Along with this seed was sown finely minced crown gall from a live apple tree, after which the seed was covered as usual.

April 10, 1903. These seedlings were dug and examined and all found to be apparently healthy

Plots 19 to 23 Inclusive, Experiment Failed.

Plot 24.

Six trees affected with crown gall were used. The gall was cut off carefully with a sharp knife and the trees treated as follows: 3 trees with a solution of bluestone, 2 lbs. to 50 gallons of water; 3 trees treated with a solution of bluestone, 4 lbs. to 50 gallons of water. When examined April 10, 1903, the three plants treated with the weak solution showed that the gall had developed again to some extent, that the plants had not been able to put forth sound roots and that the trees had made practically no growth. The second lot treated with the strong solution of bluestone all died.

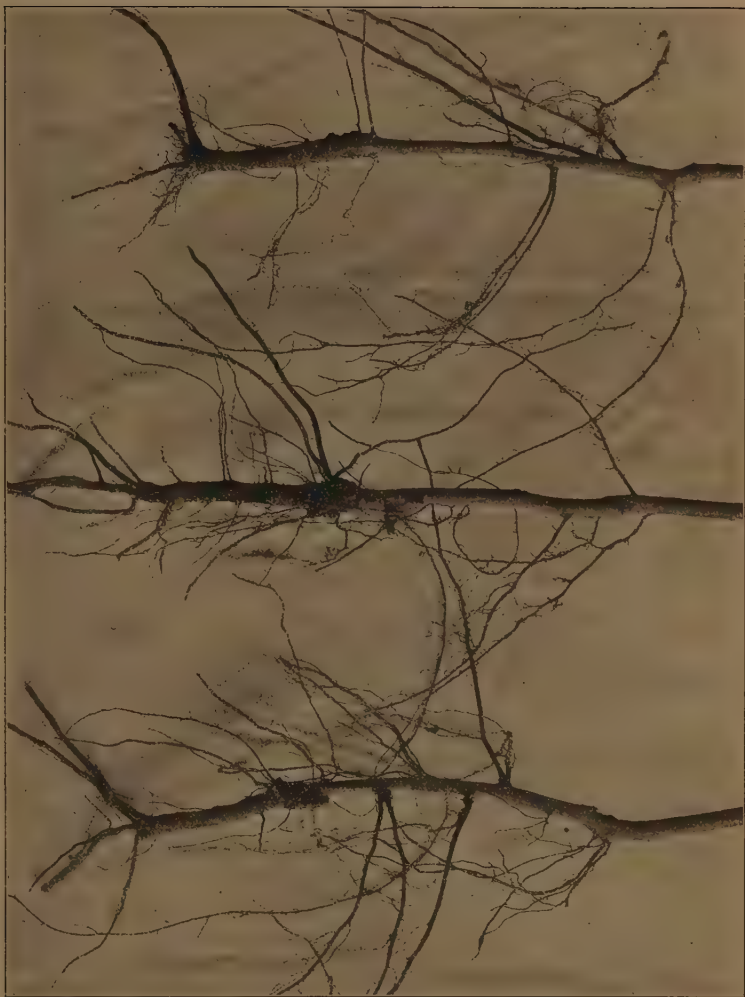


Fig. 34—One year grafts, long clons used on healthy apple roots. Minced galls sown in row. Two on right appear to show incipient galls.

Plot 25.

To compare with the above, 3 trees of like character were planted without removing the galls or treating them in any manner.

April 10, 1903. These trees made very good growth, and have thrown out a large mass of fibrous roots from the galls and adjacent thereto, but they have developed no normal roots and there is no attempt of the roots to grow downward into the soil. The galls have continued to develop.

By comparing this statement with that above, it will be seen that trees affected with the disease appeared to grow off rapidly when the diseased tissue was left intact, whereas, if the gall is interfered with by cutting, the tree is not able to grow, as apparently all that portion of the root below the gall is practically atrophied. The peculiar fibrous character of the growth that is put out from the galls and the parts adjacent thereto, is shown in Fig. 35, a photograph made from these trees and the atrophied condition of the roots below the gall on apple trees is shown by Fig. 36, in which the fibrous roots are somewhat stripped away, and the first formed roots of the young plant still remain. This latter figure shows very markedly the atrophied character of the roots. These plants were taken from nursery stock.

Plot 26.

Six well grown trees showing marked cases of crown gall were treated as follows: The galls were carefully cut away with a sharp knife, then 3 of the trees were painted with a strong Bordeaux made by using 4 lbs. copper sulphate, 5 lbs. lime to 25 gallons of water; the other 3 were painted with a Bordeaux made like the above, except that only 10 gallons of water were used.

April 10, 1903. The 3 plants treated with the weaker strength of Bordeaux have formed a few fibrous roots, but no normal roots; the galls have developed slightly; the plants have made very slight growth indeed. Of the 3 plants treated with the strong preparation of Bordeaux, 1 is dead, the other 2 have grown very little. Some fibrous roots have developed, but no normal roots, the galls have grown out slightly.



FIG. 35.—Apple trees affected with Crown Gall, showing enormous development of fibrous roots.

Plot 27.

Three trees similar to the above, showing like cases of crown gall were planted without cutting away the gall or treating the trees in any manner.

April 10, 1903. One of these plants has made a good growth and it has developed a few normal roots: the other 2 have not made good growth, and the galls have developed decidedly large quantity of fibrous roots and no normal roots. Our experience has usually shown that well grown nursery stock, when not too seriously affected with crown gall, grows off well the first few years, but ultimately fails. This makes the deceptive character of such trees plain.

Plot 28.

Three plants affected with crown gall like the above. The galls cut off and the trees left untreated, planted in the nursery row.

April 10, 1903. These 3 plants have made very little growth, the galls have developed considerably, no normal roots have been formed.

Plot 29.

Three trees affected with the crown gall like the above. The galls were cut off carefully with a sharp knife and the roots treated with copperas (sulphate of iron), 4 lbs. to 50 gallons of water, then planted in the nursery row.

April 10, 1903. These plants have made a slight growth, the galls having developed slightly. Some fibrous roots have developed, no normal roots.

Plot 30.

Three trees like the above in every way, selected and planted in the nursery row with the galls intact, no treatment.

April 10, 1903. Of these plants, 1 died, 1 made fair growth, with the characteristic crown gall formation of the roots. The other made a good growth with an enormous development of fibrous roots, but no normal roots.

Plot 31.

Three trees affected with crown gall were selected, the galls were cut off with a sharp knife, the cut surface and roots treated with a thin paste of lime, like a white wash, then planted in nursery row.



Fig. 36—Crown gall of apple on nursery stock—galls exposed.

April 10, 1903. Of these 3 trees, 1 is dead, the other 2 are barely alive, so injured by the treatment that they did not even make fibrous roots from the vicinity of the diseased tissue.

Plot 32 omitted.

Plot 33.

Two trees with very characteristic crown gall knots, selected, and five trees from the same lot which did not show the characteristic growth of the crown gall, but did show the characteristic bundles of fibrous roots about the crown. Trees were all planted in nursery row.

April 10, 1903. The two trees have made a fair growth with the characteristic crown gall development of fibrous roots. Of the five plants selected, one has made a normal growth, apparently not sufficiently diseased to prevent the formation of a normal root system. Three have developed the characteristic growth of crown gall infested trees, and one tree appears to be injured from other cause. The above selection was made in order that we might learn something about how closely trees should be rejected, which show any trace of crown gall; *i. e.*, when the fibrous root bundles are present but not the cancerous growth. In my opinion, nursery stock can not be too carefully sorted, for the interest of the planter.

Plot 34.

Several trees showing characteristic traces of crown gall were treated with the strong Bordeaux after cutting off the diseased tissue. Of these trees, two showed the characteristic knots of the crown gall, while five showed only the fibrous root clusters about the crown.

April 10, 1903. The three trees that showed the characteristic knots show the usual development of trees badly diseased with crown gall. Of the five plants showing the fibrous roots, three now show the characteristic growth of crown gall, and two have made more normal growth, and apparently might recover.

In the above plot, we wished to observe the effect of treatment on trees presumably but slightly affected by crown gall. They were associated with badly diseased trees for comparison. One cannot base any strong statement on such a test, but the observation is not reassuring to planters.

Plot 35.

Several trees affected with the crown gall were selected. The galls uncut, the trees treated with bluestone, 4 lbs. to the 50 gallons of

water, planted in the nursery row. Of these trees, three are characteristic, showing decided cases, with the knots present; five show only the fibrous roots about the crown of the trees.

April 10, 1903. Somewhat injured by treatment. Of the five plants slightly diseased, one is dead, the other four have developed characteristic growth of crown gall; all appear to be injured by the treatment.



Fig. 37—Apple tree dying from crown gall 14 years after planting.

IN THE ORCHARD.

As stated in the opening paragraphs of this paper, our experience with this trouble is limited to recent date. When the writer planted the first portion of the Experiment Station Orchard in 1889, he was wholly unacquainted with crown gall on apple trees. While due care

was exercised in handling these first trees planted, some few diseased trees must have been set out. It would appear the cases were but slightly developed when planted, as none of the trees showed the effect of the disease until in the fourteenth summer. Early in 1902, one tree of Nero and one tree of Peach Pond, showed marked signs of weakness. A search for borers revealed no trouble from that cause, but did show the presence of the warty growth and fibrous roots characteristic of crown gall. These were both well grown trees and had borne fruit on several occasions. The trouble progressed slowly and the trees were allowed to stand for observation until the writing of this paper was begun. Then August 1, 1903, both were carefully dug up and examined. They had developed in the early years of their growth an excellent root system, but the cancerous growth of the gall had steadily eaten around the stem at the crown of the roots, until the bast tissues were almost entirely gone. The roots were already largely dead and some were decayed. No other injury than the gall could be found. Both the trees stood in good situations, with strong trees about them. Fig. 37 shows a photograph of Nero shortly before it was dug. The past Spring all the limbs were cut back so as to leave a very scanty top but no growth whatever was made. From the results of the trouble on these two trees it appears that plants of the finest vigor yield readily to its attack. The question now arises, has the infection spread largely over the Station orchards.

Our observation in more recently planted orchards shows that it is not usual for trees showing an attack of this trouble to form a normal root system. The root development is weak and confined to the surface. Such trees can be readily shaken, thus revealing lack of depth of the root system. We, also, are of the opinion that badly diseased trees, such as are now very commonly found in nursery stock, will not ordinarily come into fruiting.

WHAT CAUSES THE TROUBLE?

The foregoing notes and illustrations tell pretty much the popular story of crown gall, from the seedling stock to the grown nursery tree as it is disseminated in commerce, and also the probable result of planting such diseased stock in the orchard. At another time

we hope to present a more scientific treatment of this subject, dealing technically with the organism which causes the trouble.

Among American investigators, Prof. J. W. Toumey has published, perhaps the best studies on the life history of the organism which causes the abnormal growths now commonly called crown gall or root gall and observed upon a great variety of fruit trees. While there are many troubles of plants called by various names as Root Knot, Root Gall, Club Root, etc., it would appear that the evidence thus far presented shows that the peculiar outgrowths, more or less encircling the axis of these plants at or near the junction of the stem with the root, may all be referred either to one or more closely related species of Slime-molds. While Prof. Toumey has named the species studied by him on Almond, *Dendrophagus globosus*, in our opinion there has not yet been published sufficient data to warrant us in saying the same species causes the crown gall on apple trees. This point is not one of great practical importance at this time, but the fact that the disease is due to a low parasitic organism which may exist in the soil and be propagated from plant to plant, is of great importance. Whether the organisms belonging to the Slime-molds (*Myxomycetes*) are animal or vegetable, has not been well settled, as they are on the border of the two great organic kingdoms and sometimes assigned to one, and at another time, to the other kingdom.

This organism undoubtedly attacks the seedling apple tree in the nursery. The organism gaining entrance to the radicle or main root stock soon after germination, by entering through one or more of the tender root hairs. Once ensconced in the tissues of its host it brings about the abnormal growth of fibrous roots observed on seedlings as shown in Fig. 27, and when these seedlings are used for stocks in the nursery, the crown gall as observed on nursery stock results.

WHAT SHALL BE DONE TO STAY THE TROUBLE?

The results of our work are sufficient to warrant the statement that all nursery stock should be carefully sorted and trees showing the abnormal growth should be destroyed. This may fall heavily upon the nurserymen, but the orchardists' interests are in the long run the interests of the nurserymen. That is, the nurserymen cannot afford

to defeat the success of their patrons by selling diseased stock. If they do this, who will be their future buyers? From such published data as we have and from our experiments, there appears to be no hope of remedial treatment.

CONCLUSIONS.

The following paragraphs seem to fairly express the results of our investigation so far as completed.

1. The organism which produces the abnormal growth known as crown gall on the apple appears to gain entrance to the apple seedling in the nursery.

2. The diseased seedlings can be detected by inspection. The unusual amount of fibrous roots at and below the crown being the characteristic depended upon for recognition of the trouble.

3. Nurserymen can select the seedlings used so as to largely control this trouble. No one should expect to entirely prevent its occurrence in the nursery now that it has become so wide spread.

4. Persons planting fruit trees should reject with the greatest care all trees which show the cancerous growth about the crown or a sufficiently abnormal development of fibrous roots about the crown to warrant belief that the plants are diseased. One should not confound the knots caused by wooly aphis with this disease.

5. Apparently, crown gall can be readily inoculated from a diseased plant into healthy ones, hence diseased plants should not be allowed to remain among healthy ones in the orchard. Cultivating the orchard may possibly serve to spread the disease by carrying diseased tissue from one tree to another, but we have not definite data to cite in support of this proposition.

The foregoing notes are issued to meet the great demand made upon us for information by orchardists and nurserymen. The study of the subject is far from complete, and the further investigation may show that there is more than one trouble occurring upon nursery stock, which we now lump together as crown gall.

I am much indebted to Mr. J. L. Phillips, recently promoted to the position of State Entomologist, for assistance in carrying out the details of this work.

WM. B. ALWOOD,
Mycologist, etc.

Issued September 15, 1903.